The Economic Value of Contraception: A Comparison of 15 Methods

ABSTRACT

Objectives. The purpose of the study was to determine the clinical and economic impact of alternative contraceptive methods.

Methods. Direct medical costs (method use, side effects, and unintended pregnancies) associated with 15 contraceptive methods were modeled from the perspectives of a private payer and a publicly funded program. Cost data were drawn from a national claims database and Medi-Cal. The main outcome measures included 1-year and 5-year costs and number of pregnancies avoided compared with use of no contraceptive method.

Results. All 15 contraceptives were more effective and less costly than no method. Over 5 years, the copper-T IUD, vasectomy, the contraceptive implant, and the injectable contraceptive were the most cost-effective, saving $14 122, $13 899, $13 813, and $13 373, respectively, and preventing approximately the same number of pregnancies (4.2) per person. Because of their high failure rates, barrier methods, spermicides, withdrawal, and periodic abstinence were costly but still saved from $8933 to $12 239 over 5 years. Oral contraceptives fell between these groups, costing $1784 over 5 years, saving $12 879, and preventing 4.1 pregnancies.

Conclusions. Contraceptives save health care resources by preventing unintended pregnancies. Up-front acquisition costs are inaccurate predictors of the total economic costs of competing contraceptive methods. (*Am J Public Health.* 1995;85:494–503)

James Trussell, PhD, Joseph A. Leveque, MD, MBA, Jacqueline D. Koenig, Robert London, MD, Spencer Borden, MD, MBA, Joan Henneberry, Katherine D. LaGuardia, MD, MPH, Felicia Stewart, MD, T. George Wilson, MD, PhD, Susan Wysocki, RNC, NP, and Michael Strauss, MD, MPH

Introduction

Contraceptive technology is a medical success story. For women who should not become pregnant because of medical problems, contraception saves lives and prevents morbidity. For the majority of users, contraception enhances quality of life, allowing couples to choose whether and when they wish to have children. The two essentially irreversible methods, tubal ligation and vasectomy, provide the greatest protection from unintended pregnancy. Reversible methods, such as spermicides, barrier methods, periodic abstinence, oral contraceptives, the implant, and the injectable contraceptive, reduce the incidence of pregnancy while preserving the capacity to bear children. These methods provide individuals with considerable options, allowing them to choose the contraceptive that best meets their needs for ease and safety of use, reversibility, and efficacy in preventing unintended pregnancy and sexually transmitted diseases. This study adds one more critical factor to that list: cost. Health care consumers and policymakers must understand the costs associated with these contraceptive choices to make well-informed decisions about their use.

We developed an economic model to compare the effectiveness and costs per person of 15 contraceptive methods: tubal ligation, vasectomy, oral contraceptives, contraceptive implant, injectable contraceptive, progesterone-T IUD, copper-T IUD, diaphragm, male condom, female condom, sponge, spermicides, cervical cap, withdrawal, and periodic abstinence. (Tables 1 through 4 summarize key model assumptions.) We examined what would happen if all sexually active women of reproductive age in the United States used each particular method for periods of 1, 2, 3, 4, or 5 years. For each method, it was assumed that a woman remains on that method for the entire period, even if she experiences a side effect or unintended pregnancy. Although not necessarily reflective of clinical practice, this approach allows a direct comparison of methods.

Methods

Method Effectiveness

The outcome measure calculated for each method was the number of pregnan-

James Trussell is with the Office of Population Research, the Woodrow Wilson School of Public and International Affairs, and the Department of Economics, Princeton University, Princeton, NJ. Joseph A. Leveque, Jacqueline D. Koenig, and Michael J. Strauss are with Health Technology Associates, Washington, DC. Robert London is with the Department of Obstetrics and Gynecology, Kaiser Permanente Medical Group, Mid-Atlantic Region, Baltimore, Md. Spencer Borden is with the Wyatt Company, Wellesley, Mass. Joan Henneberry is with the Colorado Department of Health, Denver, Colo. Katherine D. La Guardia is with the Department of Obstetrics and Gynecology, Cornell University Medical College, New York, NY. Felicia Stewart is with the Office of Population Affairs, US Department of Health and Human Services, Bethesda, Md. T. George Wilson is with the California Department of Health Services, Sacramento, Calif. Susan Wysocki is with the National Association of Nurse Practitioners in Reproductive Health, Washington, DC.

Requests for reprints should be sent to James Trussell, PhD, Office of Population Research, Princeton University, 21 Prospect Ave, Princeton, NJ 08544; fax (609) 258-1418; tel (609) 258-4946; e-mail trussell @ princeton. edu.

This paper was accepted November 21, 1994.

Editor's Note. See related editorial by Lee and Stewart (p. 479) in this issue.

cies avoided, defined as the difference between the number of pregnancies expected to occur if no method was used and the number expected to occur with that method. The model assumed first-year failure rates during typical use (both perfect and imperfect use) (Table 1).[1]

For short-term methods, we assumed the same annual failure rate applied for each of the 5 years. Decreases in failure rates frequently observed in studies because less motivated users become pregnant and are removed from observation are not relevant in our model, which assumes that all women continue to choose only the method being evaluated. The four methods intended for long-term use were assigned alternative failure rate estimates in years 2 through 5, because these reflect changes over time in method efficacy. For the implants, we estimated each year's failure rate from data on soft capsules, because these are the only ones now marketed; for the copper-T IUD, we obtained failure rates from long-term clinical trials.[2–5]

We included declining failure rates for both tubal ligations and vasectomies. Pregnancies associated with these sterilization procedures occur primarily during the first year and are typically due to surgical or equipment failures. After the first year, the risk of pregnancy becomes extremely small. For tubal ligations, we estimated declining pregnancy rates on the basis of reported cumulative probabilities of failure at 4 and 7 years.[6] For vasectomies, we reduced the pregnancy rate by 93% after the first year and kept it constant for years 2 through 5.

TABLE 1—Annual Failure Rates and Outcomes of Unintended Pregnancy for 15 Methods of Contraception

Method	Failure Rate,[a] %	Unintended Pregnancy Outcomes, %			
		Induced Abortion	Spontaneous Abortion	Ectopic Pregnancy	Term Pregnancy
Tubal ligation[b]	0.17	23.75	6.20	50.00	20.05
Vasectomy[b]	0.04	47.03	12.28	1.00	39.70
Oral contraceptives	3.00	47.03	12.28	1.00	39.70
Implant[b]	0.32	40.85	10.66	14.00	34.49
Injectable contraceptive	0.30	41.33	10.79	13.00	34.89
Progesterone-T IUD	2.00	39.90	10.42	16.00	33.68
Copper-T IUD[b]	0.42	46.08	12.03	3.00	38.90
Diaphragm	18.00	47.03	12.28	1.00	39.70
Male condom	12.00	47.03	12.28	1.00	39.70
Female condom	21.00	47.03	12.28	1.00	39.70
Sponge[c]	30.00	47.03	12.28	1.00	39.70
Spermicides	21.00	47.03	12.28	1.00	39.70
Cervical cap[c]	30.00	47.03	12.28	1.00	39.70
Withdrawal	19.00	47.03	12.28	1.00	39.70
Periodic abstinence	20.00	47.03	12.28	1.00	39.70
No method	85.00	47.03	12.28	1.00	39.70

[a]See text for references and further explanation of failure rate and unintended pregnancy outcome derivations.
[b]Failure rates for these methods represent the average of years 1 through 5: tubal ligation—0.4000%, 0.1333%, 0.1333%, 0.1333%, 0.0667%; vasectomy—0.15%, 0.01%, 0.01%, 0.01%, 0.01%; implant—0.09%, 0.31%, 0.40%, 0.40%, 0.40%; copper-T IUD—0.8%, 0.2%, 0.6%, 0.2%, 0.3%.
[c]Weighted averages of rates for parous and nulliparous women of reproductive age at risk of pregnancy (weights obtained from the 1988 National Survey of Family Growth, unpublished data).

Costs

The model addressed three types of direct medical costs: method use, adverse and beneficial side effects, and unintended pregnancies. Direct nonmedical costs (e.g., costs of traveling to receive care) and indirect costs (e.g., decreased productivity while hospitalized or recovering from delivery) were excluded. All costs were evaluated from the perspective of a private payer (managed payment model) and a public payer (public payer model). We assume that both types of payers cover the full costs of all methods of contraception, sterilization, abortion, and childbirth. Although not reflective of current US coverage patterns, because widespread coverage of abortions is lacking in the public sector and widespread coverage of contraception is lacking in the private sector, this assumption reflects costs to society and allows plans to be compared. All costs beyond the first year were discounted to present value at a 5% annual rate.

Data sources. Data for the managed payment model were obtained principally from MEDSTAT Systems, Inc (Ann Arbor, Mich), whose MarketScan database reflects the experience of large employers from 45 major metropolitan areas. The data are collected from commercial insurers, BlueCross BlueShield plans, third-party administrators, and self-administrators. Most plans pay negotiated or discounted fees. Payments represent the 1991 amounts received by the providers from all sources. Data for this study were based on over 20 000 records.

The public payer model cost estimates were from 1993 fee schedules and statistics for Medi-Cal, the California Medicaid program. Medi-Cal provided the average allowance for hospitals and physicians. For procedures for which Medi-Cal data were incomplete, we estimated costs as the product of the managed payment model amount for the procedure and the overall ratio of Medi-Cal to managed payment for all procedures (57%). When MEDSTAT data were unavailable, we reversed this algorithm.

Method use costs. Costs for office visits, tubal ligations, and vasectomies in the managed payment model were obtained from the MarketScan database, as identified by descriptive billing codes. Drug and device costs in the managed payment model were based on average wholesale price in 1993 (Table 2).[7] We used retail prices for condoms, sponges, and spermicides. The implant insertion and removal costs were estimated from physician surveys reported in 1991 newspaper articles[8–13] and from one practicing physician in Philadelphia. In the public payer model we used Medi-Cal's maximum allowable amount and data from the California Office of Family Planning. Where appropriate, contraceptive costs were adjusted to reflect nonuse during pregnancy and reinitiation following the outcome of an unintended pregnancy. Costs of routine gynecological care unrelated to contraceptive use were not included.

One important methodological issue involved how to model the costs of removing a copper-T IUD or the hormonal implant, because the timing of these events varies by patient. We assumed that removal occurred once within the time frame of any analysis (excluding

TABLE 2—Unit Costs for Methods and Associated Services

Method	Unit Cost,[a] $	
	Managed Payment Model	Public Payer Model
Tubal ligation[b]	2466.80	1190.00
Vasectomy[b]	755.70	353.28
Oral contraceptives		
Drug	21.00/cycle	17.70/cycle
Office visit[b]	38.00	16.56
Implant		
Drug[b]	365.00	365.00
Insertion[b]	333.00	47.96
Removal	100.00	79.64
Injectable contraceptive		
Drug	30.00/quarter	30.00/quarter
Office visit	38.00/quarter	16.56/quarter
Progesterone-T IUD		
Device	82.00	82.00
Insertion	207.00	62.42
Removal	70.00	10.80
Copper-T IUD		
Device[b]	184.00	109.00
Insertion[b]	207.00	62.42
Removal	70.00	10.80
Diaphragm[c]		
Device (first and third year)	18.00	15.00
Office visit (device fitting)[b]	38.00	15.59
Spermicidal jelly[d]	12.00	8.75
Male condom[c]	1.00	0.33
Female condom[c]	3.66	1.25
Sponge[c]	1.50	0.83
Spermicides[c,d]	12.00	8.75
Cervical cap[c]		
Device (first and third year)	31.00	19.00
Office visit (device fitting)[b]	38.00	15.59
Spermicidal jelly[d]	12.00	8.75
Withdrawal	0.00	0.00
Periodic abstinence	0.00	0.00
No method	0.00	0.00

[a]See text for source of cost estimates.
[b]First year only.
[c]Method costs were calculated on 83 acts of intercourse per year (personal communication of unpublished tabulations from 1989, 1990, 1991, and 1993 General Social Surveys, Tom W. Smith, PhD, National Opinion Research Center, 1993). Diaphragm and cap users were assumed to replace their devices during the third year.
[d]Used for 10 acts of intercourse.

removals following pregnancy). For example, in any analysis that compared methods over a single year, we assumed that in all cases the hormonal implants and copper-T IUDs would be removed at the end of that year.

Side-effect costs. Frequencies of common adverse and beneficial side effects for each method were estimated from the literature or, where literature was lacking, the investigators' experience.[5,14–18] Costs of side effects were estimated with Medi-Cal and MEDSTAT data (Table 3).

Costs of unintended pregnancy. We included costs incurred from time of conception until pregnancy termination, including costs associated with ectopic pregnancy, spontaneous abortion, induced abortion, and term delivery. The latter consists of prenatal care, delivery, and newborn hospitalization (Table 4). Cost estimates for term delivery ended at the time of maternal and infant discharge from the delivery facility.

Estimating induced abortion, spontaneous abortion, and term delivery rates involved two steps. First, we determined the ectopic pregnancy rate for each method.[14] Then, for all unintended pregnancies that were not ectopic, we assumed the following distribution: 47.5% induced abortion; 12.4% spontaneous abortion; and 40.1% term delivery (Table 1).[14]

We derived the 1991 average payment for an induced abortion ($416) in the managed payment model by combining the average payments for those provided in hospital (7%) and nonhospital (93%) settings.[19–21] The hospital-setting payment ($1785) came directly from the MEDSTAT database. We derived the nonhospital average payment ($313) by combining data on payments for induced abortions by setting and by gestational week and then weighting those payments by the percentage distribution of abortions by gestational week.[20,21]

Attempt To Minimize Bias

Our study adhered to published principles to minimize bias in economic analyses funded by pharmaceutical companies.[22] The sponsor (Wyeth-Ayerst Laboratories) played no role in the selection of investigators, the design of the model, or the interpretation of results. We also performed multiple sensitivity analyses to examine the effects of alternative assumptions on the results.

Results

Base-Case Analyses

The cost of an unintended pregnancy is substantial (Table 4). Table 5 and Figures 1 and 2 illustrate how unintended pregnancy costs combine with method and side-effects costs to determine total 1-year and 5-year costs associated with each contraceptive method. For example, in a highly effective method such as tubal ligation, 5-year method costs reflect 96% of total costs (managed payment model). In a much less effective method such as the male condom, 5-year total costs are similar, but the costs of unintended pregnancies reflect 85% of the total.

In the managed payment model, the least costly method after 1 year of use is the injectable contraceptive, followed by oral contraceptives and the progesterone-T IUD. In a 5-year analysis, however, the least costly method is the copper-T IUD, followed by vasectomy and the implant. In the public payer model, the injectable and the two IUDs have the lowest costs at 1 year. By 5 years, however, vasectomy and the implant join the copper-T IUD as the least costly methods.

Figure 3 shows how the cumulative costs associated with the seven most effective methods compare over time in the managed payment model. A method becomes less costly than an alternative when its cost line passes under that of the other method. The copper-T IUD becomes less costly than the injectable at approximately 2.0 years. The implant

TABLE 3—Incidence and Unit Costs of Side Effects for 15 Contraceptives

Method	Side Effect[a]	Incidence,[b] %	Unit Cost,[c] $ Managed Payment Model	Unit Cost,[c] $ Public Payer Model
Tubal ligation	Postoperative complication	1.200[15,d]	4950.00	2831.00
Vasectomy	Postoperative infection	0.043[14,d]	144.00	91.34
Oral contraceptives	Myocardial infarction	0.001[14]	15 554.60	8374.38
	Stroke	0.003[14]	18 384.05	3898.46
	Pulmonary embolism/ thrombophlebitis[e]	0.011[14]	7225.19	4190.05
	Gallbladder disease	0.093[14]	5622.37	3009.94
	Ovarian cysts	0.087[14]	(1687.00)	(940.00)
	Benign breast disease	0.023[14]	(851.50)	(486.50)
Implant	Infection at implant site	0.700[2,d]	49.00	27.56
	Irregular bleeding	2.500[d,f]	59.00	37.56
Injectable contraceptive	Irregular bleeding	2.500[d,f]	59.00	37.56
Progesterone-T IUD	Iron deficiency anemia	2.000[16]	79.00	38.48
	Uterine perforation	0.110[16]	1687.00	1134.00
Copper-T IUD	Iron deficiency anemia	2.000[16]	79.46	38.48
	Uterine perforation	0.110[16,d]	1687.00	1134.00
Diaphragm	Urinary tract infection	15.000[f]	20.00	20.00
	Vaginitis	15.000[f]	16.00	16.00
	Cervical cancer	0.006	(6463.00)	(3684.00)
	Cervical intraepithelial neoplasia	0.053	(537.12)	(227.74)
Male condom	Cervical cancer	0.006	(6463.00)	(3684.00)
	Cervical intraepithelial neoplasia	0.053	(537.12)	(227.74)
Female condom	Cervical cancer	0.006	(6463.00)	(3684.00)
	Cervical intraepithelial neoplasia	0.053	(537.12)	(227.74)
Sponge	Urinary tract infection	15.000[f]	20.00	20.00
	Vaginitis	15.000[f]	16.00	16.00
	Cervical cancer	0.006	(6463.00)	(3684.00)
	Cervical intraepithelial neoplasia	0.053	(537.12)	(227.74)
Spermicides	Urinary tract infection	15.000[f]	20.00	20.00
	Vaginitis	15.000[f]	16.00	16.00
	Cervical cancer	0.006	(6463.00)	(3684.00)
	Cervical intraepithelial neoplasia	0.053	(537.12)	(227.74)
Cervical cap	Urinary tract infection	15.000[f]	20.00	20.00
	Vaginitis	15.000[f]	16.00	16.00
	Cervical cancer	0.006	(6463.00)	(3684.00)
	Cervical intraepithelial neoplasia	0.053	(537.12)	(227.74)
Withdrawal	None	...	...	...
Periodic abstinence	None	...	...	...
No method	None	...	...	...

[a]Note regarding the inclusion and exclusion of side effects: Whether the net effect of oral contraceptive use on reproductive cancers is positive or negative is unknown, but it is estimated to be very small.[17,18] For simplicity, we assume that the cost of the increased risk of cervical, breast, and liver cancers is exactly offset by the cost of the decreased risk of ovarian and endometrial cancers. Likewise, we assume that the use of progestin-only contraceptives has no effect on the cost of the net risk of reproductive cancers or the risk of benign breast disease or ovarian cysts. Given the very small impact ($1.66 per year in the managed payment model) of combined oral contraceptive use on the risk of benign breast disease or ovarian cysts, the latter assumption makes no difference to the results.

[b]Incidences for side effects are the same in the managed payment and public payer models.

[c]See text for source of cost estimates, except for the costs of tubal ligation complications, for which we surveyed three coinvestigators and one external physician. Benefits are negative costs and are shown in parentheses.

[d]First year only.

[e]The unit cost is the weighted average of the costs of pulmonary embolism and thrombophlebitis, with weights reflecting their relative frequencies in the Marketscan database.

[f]Estimates based on investigators' clinical experience.

TABLE 4—Pregnancy Outcome Costs[a]

Pregnancy Outcome	Cost, $ Managed Payment Model	Cost, $ Public Payer Model
Ectopic pregnancy	4994	2804
Induced abortion	416	345
Spontaneous abortion	1038	416
Term pregnancy	8619	3623[b]
Maternity care/ delivery	5512	...
Newborn hospitalization	3107	...

[a]See text for source of cost estimates.

[b]Newborn hospitalization and maternity/ delivery costs could not be separated.

becomes less costly than the injectable at around 3.0 years.

Figure 4 combines savings and efficacy into one graph, illustrating the relative cost-effectiveness of each method. The vertical axis reflects 5-year savings compared with use of no method; the horizontal axis reflects unintended pregnancies avoided compared with use of no method. Use of no method over 5 years results in 4.25 unintended pregnancies at a cost of $14 663 in the managed payment model and $6490 in the public payer model. One method is viewed as more cost-effective than another if it is at least as effective and provides more savings or is at least as cost-saving and prevents more pregnancies. For example, vasectomy ($13 899 in savings, 4.248 pregnancies avoided), the implant ($13 813 in savings, 4.234 pregnancies avoided), and the copper-T IUD ($14 122 in savings, 4.229 pregnancies avoided) all are more cost-effective than oral contraceptives, being both higher and farther to the right. In cost-effectiveness jargon, they "dominate" (better outcome, more savings). Similarly, oral contraceptives dominate all other reversible methods requiring continuous user compliance except for the injectable. Vasectomy dominates the implant but provides fewer savings than the copper-T IUD. The top four cost-effective methods were the same in the public payer model.

Sensitivity Analyses

Model results proved sensitive to many underlying assumptions, particu-

larly method efficacy. All analyses were performed in the managed payment model except where noted. (Detailed results are available from the first author.)

1. We assumed perfect rather than typical method use, with correspondingly lower failure rates.[1] (Failure rates were not changed for tubal ligation, the implant, and the injectable contraceptive.) The largest changes were for methods that were less effective during typical use. Cost savings increased most for the female condom (by $2661), withdrawal (by $2588), spermicides (by $2554), and periodic abstinence (by $2415). Although the copper-T IUD remained the most cost-saving, withdrawal became the second most cost-saving, followed closely by vasectomy, the implant, the male condom, and periodic abstinence. The cervical cap and sponge remained the least cost-saving methods.

2. We assumed typical efficacy in the first year, but then failure rates during perfect use in years 2 to 5 to reflect assumed learning by doing. (Failure rates were not varied for vasectomy, tubal ligation, the implant, the injectable, or the copper-T IUD.) Although savings increased for all methods tested, the copper-T IUD, vasectomy, and the implant remained the most cost-effective at 5 years.

3. We assumed the implant failure rates to be those stated in the package insert (average annual failure rate 0.78%[2]), which are based in part on less effective hard capsules that are no longer marketed. (The average annual failure rate for soft capsules is 0.32%.) This change increased costs by $97, with $13 716 total savings and 4.211 pregnancies avoided over 5 years compared with no method. Under this scenario, the implant was slightly less cost-effective but after 3 years still saved more resources than the injectable. In addition, this scenario did not change the implant's position in Figure 3 relative to all other methods.

4. Combining the male condom with each method[23] increased the number of pregnancies avoided for all methods; the increased numbers ranged from 4.125 for condom and cervical cap or condom and sponge to 4.250 for vasectomy plus condom. The increased effectiveness had its greatest impact on the sponge and cervical cap, with about $13 225 in cost savings (a 48% increase) for each method. Periodic abstinence and withdrawal became the least costly methods at 5 years, followed by the copper-T IUD. Cost

TABLE 5—Total Annual and Cumulative Costs[a] of Contraceptive Methods over 5 Years

		Cost, $			
		Managed Payment Model		Public Payer Model	
Method	Year	Annual	Cumulative[b]	Annual	Cumulative[b]
Tubal ligation	1	2554	2554	1238	1238
	2	9	2562	4	1242
	3	8	2571	4	1246
	4	8	2579	4	1250
	5	5	2584	2	1252
Vasectomy	1	763	763	356	356
	2	0	763	0	357
	3	0	763	0	357
	4	0	764	0	357
	5	0	764	0	357
Oral contraceptives	1	422	422	293	293
	2	336	788	263	556
	3	348	1136	251	807
	4	332	1468	239	1046
	5	316	1784	227	1273
Implant	1	704[c]	804[d]	416[c]	496[d]
	2	14[c]	813[d]	7[c]	499[d]
	3	17[c]	826[d]	8[c]	504[d]
	4	16[c]	838[d]	8[c]	508[d]
	5	98	850[d]	73	513[d]
Injectable contraceptive	1	285	285	192	192
	2	270	555	182	375
	3	257	812	174	548
	4	245	1057	165	714
	5	233	1290	158	871
Progesterone-T IUD	1	449	449	197	197
	2	428	877	188	385
	3	407	1284	179	564
	4	388	1672	170	735
	5	370	2042	162	897
Copper-T IUD	1	428[c]	498[d]	188[c]	199[d]
	2	10[c]	504[d]	4[c]	203[d]
	3	25[c]	526[d]	11[c]	213[d]
	4	9[c]	531[d]	4[c]	216[d]
	5	69	540[d]	14	221[d]
Diaphragm	1	852	852	414	414
	2	750	1601	362	776
	3	729	2330	357	1133
	4	684	3015	331	1464
	5	652	3666	315	1780
Male condom	1	533	533	227	227
	2	508	1041	216	443
	3	484	1525	206	649
	4	461	1985	196	846
	5	439	2424	187	1033
Female condom	1	1072	1072	446	446
	2	1021	2092	425	871
	3	972	3064	405	1276
	4	926	3990	386	1662
	5	882	4872	367	2029
Sponge	1	1264	1264	575	575
	2	1191	2455	541	1116
	3	1135	3590	516	1632
	4	1081	4671	491	2123
	5	1029	5700	468	2591

(Continued)

TABLE 5—*Continued*

Method	Year	Cost, $ Managed Payment Model Annual	Managed Payment Model Cumulative[b]	Public Payer Model Annual	Public Payer Model Cumulative[b]
Spermicides	1	913	913	435	435
	2	857	1769	409	844
	3	816	2585	389	1233
	4	777	3362	371	1604
	5	740	4102	353	1957
Cervical cap	1	1310	1310	613	613
	2	1178	2487	550	1163
	3	1157	3644	546	1709
	4	1068	4713	499	2207
	5	1017	5730	475	2682
Withdrawal	1	721	721	319	319
	2	687	1408	304	623
	3	654	2062	289	913
	4	623	2684	276	1188
	5	593	3278	263	1451
Periodic abstinence	1	759	759	336	336
	2	723	1482	320	656
	3	688	2170	305	961
	4	656	2826	290	1251
	5	624	3450	276	1527
No method	1	3225	3225	1428	1428
	2	3072	6297	1360	2787
	3	2926	9223	1295	4082
	4	2786	12 009	1233	5316
	5	2654	14 663	1175	6490

[a]Assumes all births are unwanted, in the sense that they never would have occurred. Costs include cost of acquiring and using method (Table 2), cost of side effects (Table 3), and cost of unintended pregnancy (Tables 1 and 4). For long-term methods, costs were adjusted to reflect additional procedures performed on those who experienced a failure. For short-term methods, costs were adjusted to reflect nonuse during pregnancy.
[b]Numbers may not sum consistently because of rounding.
[c]Excludes the cost of a removal.
[d]Includes the cost of a removal.

savings actually decreased for the most effective methods, because their pregnancy rates were already so low that the few additional pregnancies avoided did not offset the additional costs of using the male condom.

5. We added emergency contraceptive pills to all nonhormonal methods that require user compliance—barrier methods, spermicides, periodic abstinence, and withdrawal.[24] We modeled emergency contraceptive pills during imperfect use of these methods; for male and female condoms, we modeled emergency contraceptive pills during perfect use at times of pure method failure (breakage and slippage) as well. Although postcoital use of emergency contraceptive pills reduces the risk of pregnancy from unprotected intercourse by at least 75%,[25] no company has sought approval from the Food and Drug Administration (FDA) to market oral contraceptives for this indication. Emergency contraceptive pills lowered the costs of barrier methods by reducing unintended pregnancies. Cost savings increased by a low of $1123 for the cervical cap and a high of $2470 for the female condom. The copper-T IUD, vasectomy, and the implant, however, remain the least costly and the most effective under this scenario.

6. Many public health programs purchase oral contraceptives at substantial discounts. For example, at $5 per cycle, the 5-year costs dropped and the savings increased substantially in the public payer model. Oral contraceptives provided more savings at 5 years than all other methods except the copper-T IUD, vasectomy, and the implant.

7. We examined each method's potential impact on the incidence and cost of sexually transmitted diseases and the resulting total costs or savings for the method. (Detailed results are available from the first author.) For the sexually transmitted diseases model, we used incidence rates from the Centers for Disease Control and Prevention and payment data from the literature and claims databases.[14,26–29] In particular, we studied transmission rates for human immunodeficiency virus, herpes simplex virus II, human papillomavirus, syphilis, uncomplicated cervical gonorrhea and chlamydia, trichomoniasis, and complicated upper reproductive tract infection (pelvic inflammatory disease). Total costs for no method rose by $407, to $15 070. The rank ordering of contraceptives by total costs changed slightly when sexually transmitted disease costs were included. At 5 years, the copper-T IUD remained the least costly method ($1051), followed by the implant ($1151), vasectomy ($1171), and the injectable ($1592). Savings compared with no method rose slightly for the barrier methods (increases ranged from $183 to $283) and decreased for the IUDs (by $103 for the copper-T and $175 for the progesterone-T). It should be emphasized, however, that the FDA allows only latex and plastic male condoms and the polyurethane female condom to be marketed as prophylactics against sexually transmitted diseases.

The relatively small impact of sexually transmitted diseases on the total cost savings of methods is due to the low incidence of sexually transmitted diseases among all women of reproductive age. The impact would be much greater if the analysis were confined to younger women, among whom the incidence of sexually transmitted diseases is much higher than the incidence among all women.[29]

Discussion

Through economic modeling and third-party payers' databases, we evaluated the impact of 15 distinct contraceptive methods on societal health care costs. The message is simple: regardless of payment mechanism or contraceptive method, contraception saves money. Preventing unintended pregnancy is highly cost-effective:

- Male and female sterilization, although they incur high initial costs, become extremely cost-effective over time for those who desire no more children.
- The most cost-effective reversible methods are the copper-T IUD, the

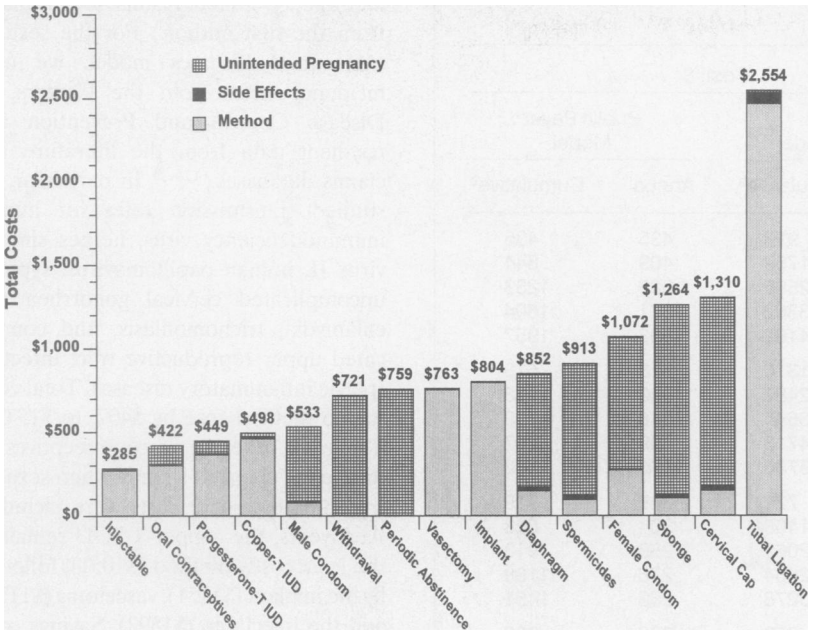

FIGURE 1—First-year costs associated with contraceptive methods in the managed payment model.

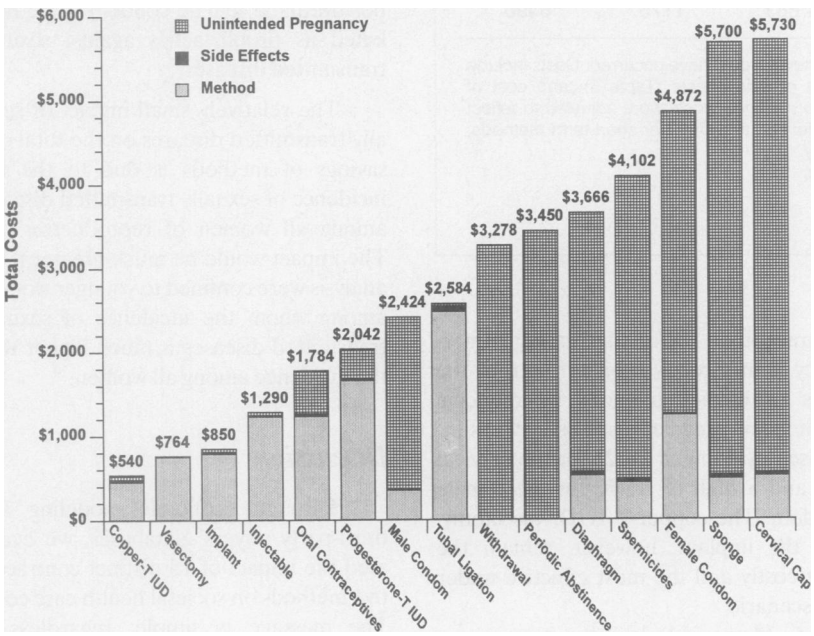

FIGURE 2—Five-year costs associated with contraceptive methods in the managed payment model.

implant, and the injectable contraceptive. Despite high initial costs, the copper-T IUD and the implant become extremely cost-effective with increased duration of use.

- Significant cost savings for barrier methods could be achieved by minimizing imperfect use.
- The use of emergency contraceptive pills with methods requiring continuous compliance also results in significant cost savings.
- Allowing for the impact of sexually transmitted diseases has little effect on overall cost savings for the typical woman.

While contraception clearly saves money, the relevant policy question is who incurs these costs and who realizes savings. The model suggests that savings generally are realized by third-party payers. They currently pay most of the bills for ectopic pregnancies, spontaneous abortions, births, and newborn hospitalizations. Most private plans also cover induced abortions,[30] but only a few public programs do so.[31] Thus, any technology that reduces the incidence of these events provides considerable savings to payers. Moreover, businesses and individuals receive an economic benefit if these savings yield lower premiums and increased profits or wages.

Ironically, contraceptive costs are often not borne by third-party payers. With private insurers, contraceptive coverage varies dramatically. Virtually all cover surgical sterilization. Some provide broad coverage for all methods, but most do not, leaving the individual to pay for contraception.[30] Public payers generally provide broader coverage than private payers, although payment levels often are low, perhaps low enough to limit access.[31]

The key question for payers and policy analysts alike is whether an increase in contraceptive coverage by a payer, or by the employer who pays the premiums, would affect that payer's bottom line. If, by expanding coverage, a payer simply finances the contraceptives that would otherwise have been purchased by individuals, then the payer's net costs are likely to increase. On the other hand, if broader coverage leads to improved access and substantially more effective contraceptive use, our models suggest that payers may save resources by avoiding the costs of unintended pregnancies. Clearly, additional studies will be necessary to address this issue.

The study design we employed has seven main limitations that must be considered in interpreting the results. First, we underestimate the societal costs of an unintended pregnancy by including pregnancy-related costs only through the time of delivery and newborn hospitalization. This approach makes sense from the payer's perspective, because individual contracts typically cover all these costs. Moreover, in many cases the insurance contract is modified after delivery, for

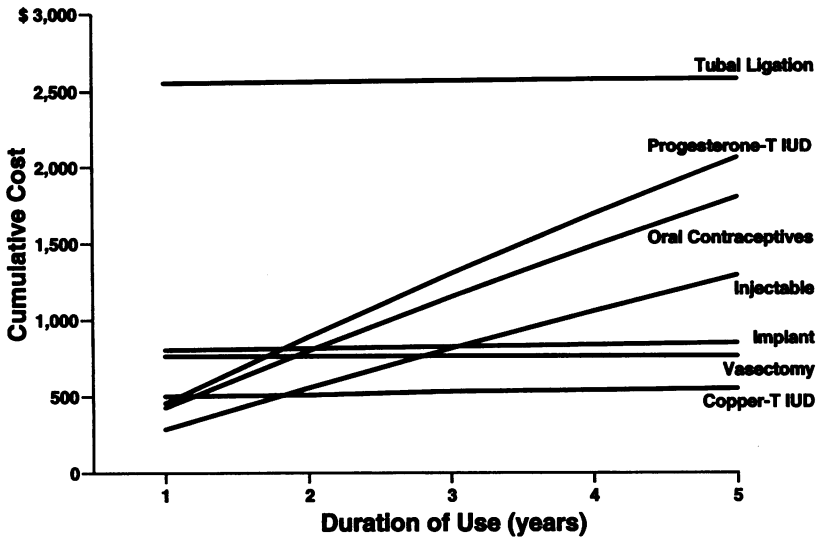

FIGURE 3—Cumulative costs associated with selected contraceptive methods in the managed payment model.

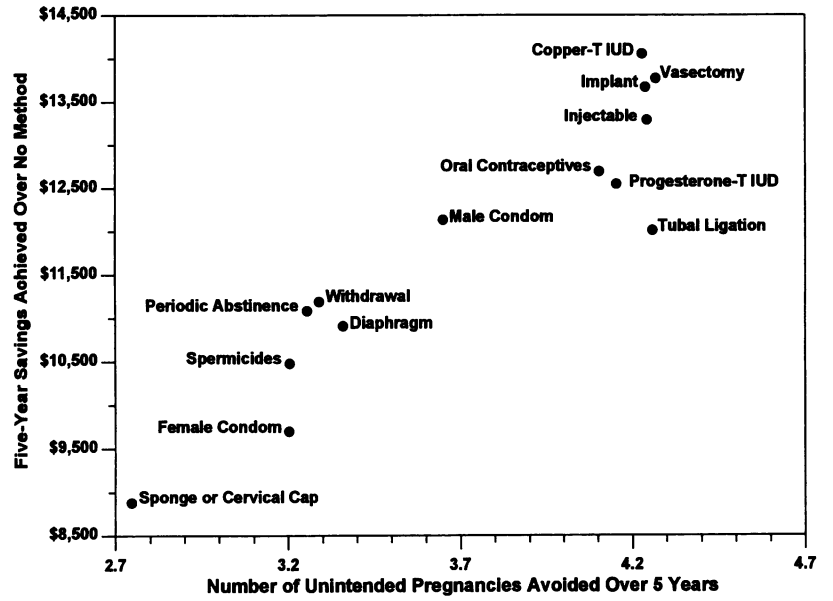

FIGURE 4—Cost savings and pregnancies avoided over 5 years for contraceptive methods compared with no method (pregnancies = 4.25, cost = $14 663) in the managed payment model.

example, going from an individual to a family policy. However, one could go further to include the costs incurred beyond the newborn hospitalization. Doing so would only increase the estimated value of contraceptive use.

Second, we overestimate the societal costs of unintended pregnancies ending in birth because we assume that these births would never have occurred. If, instead, we assume that only 31% of unintended births were unwanted in the sense that they would never have occurred[26] and that the remainder are mistimed births that would have occurred 2 years later, we obtain the costs shown in Table 6. In both models, the results demonstrate an overall decrease in the cost of using no method and the costs and savings for all methods. The 5-year cost of using no method dropped by 59% to $6029 in the managed payment model. The less effective methods also experienced substantial decreases in total costs. The most effective methods, however, experienced only minimal decreases in total costs; therefore, total savings compared with no method decreased substantially. Despite these changes, the copper-T IUD, vasectomy, and the implant remain the least costly at 5 years in both models.

Given the base-case assumption that the same fraction of nonectopic unintended pregnancies results in birth regardless of the method used, this additional assumption that the fraction of unwanted

TABLE 6—Total Costs[a] of Contraceptive Methods Assuming Most Unintended Births Are Mistimed and Would Have Occurred Later

Method	Cost, $			
	Managed Payment Model		Public Payer Model	
	Year 1	Year 5	Year 1	Year 5
Tubal ligation	2549	2574	1236	1248
Vasectomy	759	760	355	355
Oral contraceptives	355	1479	265	1145
Implant	802	822	495	501
Injectable contraceptive	279	1263	190	860
Progesterone-T IUD	411	1869	181	825
Copper-T IUD	480	498	191	203
Diaphragm	450	1838	245	1011
Male condom	265	1205	114	520
Female condom	602	2739	249	1133
Sponge	594	2652	293	1310
Spermicides	443	1969	238	1060
Cervical cap	639	2683	331	1401
Withdrawal	296	1348	141	640
Periodic abstinence	312	1419	148	673
No method	1326	6029	629	2861

[a]Costs include cost of acquiring and using method (Table 2), cost of side effects (Table 3), and cost of unintended pregnancy (Tables 1 and 4).

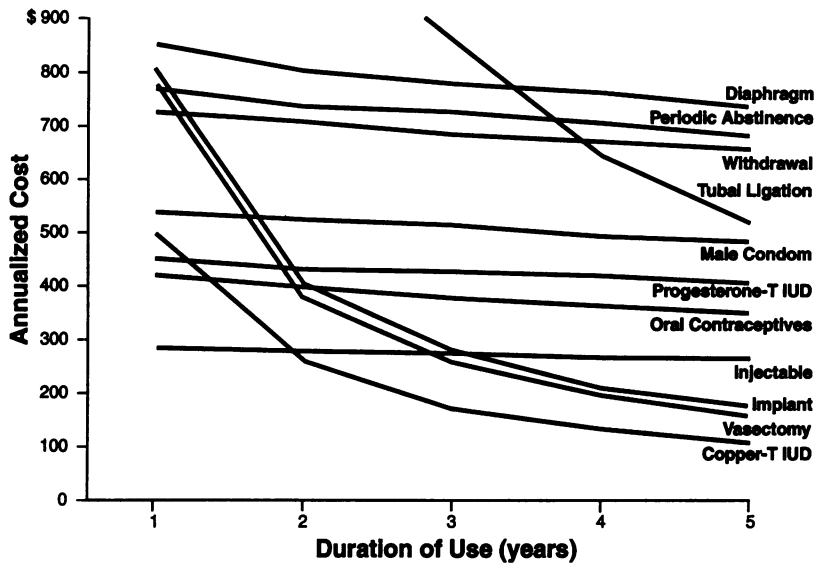

FIGURE 5—Annualized costs associated with selected contraceptive methods in the managed payment model.

births among unintended births is independent of method causes the costs of the most effective methods to be inflated relative to the costs of the less effective methods (especially no method). Other things being equal, if all women used less effective methods, the absolute number of unintended births would rise, causing a corresponding increase in the fraction unwanted.

Third, the assumption that the same fraction of nonectopic unintended pregnancies results in birth regardless of the method used causes the costs of the less effective methods (especially no method) to be inflated relative to the costs of the more effective methods. Other things being equal, if all women used less effective methods, the absolute number of unintended pregnancies would rise, thereby causing an increase in the fraction that would end in induced abortion, which is less expensive than birth.

Fourth, although our models characterize costs under two dramatically different kinds of payment systems—managed payment and public payer—neither is totally representative of the industry. Virtually all private payers now provide some form of managed care, and we believe our managed payment model provides reasonable estimates. Nevertheless, individual plans vary markedly. Some still pay amounts closer to billed charges. Other plans—for example, health maintenance organizations with salaried staff—have cost structures that are difficult to model. Similarly, our public payer model reflects the California Medicaid program, whereas other states use different approaches to financing this type of care and reimbursements are usually less generous. Therefore, we see the two models as providing benchmarks for drawing broad conclusions about the cost-effectiveness of contraceptive methods. A payer wishing to evaluate contraception for an individual plan can use our model to develop its own estimates.

Fifth, we have compared methods by assuming that they are all used for the same duration, usually 1 or 5 years. In fact, methods are used for very different lengths of time. Even methods designed for long-term use, such as the implant (5 years) and the copper-T IUD (10 years), are seldom used for their maximum potential duration. Nevertheless, our estimates can be employed to rank the cost of various methods to reflect actual durations of use in any particular situation by computing the annualized cost; if a method is typically used for d years, then its annualized cost is the cumulative cost at d years divided by d (Figure 5).

Sixth, we did not differentiate permanent from reversible methods. Yet vasectomy and tubal ligation are not relevant options until childbearing is completed. Additionally, in view of the efficacy of the copper-T IUD, the implant, and injectable contraceptives, women no longer have to choose permanent sterilization to obtain truly effective contraception.

Seventh, because our maximum time horizon is only 5 years, we understate the potential cost-effectiveness of the three methods that can be used for longer periods: tubal ligation and vasectomy, which are permanent methods, and the copper-T IUD, which can be used for 10 years.

In conclusion, our study shows that up-front acquisition costs are inaccurate predictors of the economic value of competing contraceptive methods, and that investments in contraception provide substantial economic savings and social benefits. We believe those savings justify providing broader contraceptive coverage in the context of voluntary family planning and informed consent. Highly effective methods provide the greatest cost savings, but all of the methods studied are clearly cost-effective. □

Acknowledgments

Funding was provided by Wyeth-Ayerst Laboratories, a division of American Home Products.

We are indebted to Ward Cates, Jacqui Forrest, Stanley Henshaw, Irv Sivin, Gary Stewart, and an anonymous reviewer for insightful suggestions and to Anne Stone for coordinating production of the manuscript.

References

1. Hatcher RA, Trussell J, Stewart F, et al. *Contraceptive Technology.* 16th revised ed. New York, NY: Irvington Publishers; 1994.
2. *Physicians' Desk Reference.* Montvale, NJ: Medical Economics Data; 1993.
3. Sivin I. International experience with Norplant and Norplant-2 contraceptives. *Stud Fam Plann.* 1988;19:81–94.
4. Sivin I, Stern J. Long-acting more effective copper T IUDs: a summary of U.S. experience, 1970–1975. *Stud Fam Plann.* 1979;10:263–281.
5. *ParaGard T380A Prescribing Information.* Somerville, NJ: GynoPharma Inc; April 1994.
6. Vessey M, Huggins G, Lawless M, McPherson K, Yeates D. Tubal sterilization: findings in a large prospective study. *Br J Obstet Gynaecol.* 1983;90:203–209.
7. *1993 Red Book.* Montvale, NJ: Medical Economics Data; 1993.
8. Lewin T. Five-year contraceptive implant seems headed for wide use. *The New York Times.* November 29, 1991:A1.
9. Painter K. Women welcome Norplant. *USA Today.* January 20, 1992:D1.
10. Volk E. Compulsory contraception. *The Economist.* June 1, 1991:21.
11. Welcome contrast on birth control; Gov. Wilson's contraceptive plan has risks, but it's a start. *Los Angeles Times.* May 20, 1991:B4.
12. Limits on medical coverage may affect 1 of

3 under 65. *The Atlanta Journal and Constitution.* June 19, 1991:B3.
13. Bradley T. Norplant has yet to find wide usage in Wichita. *Wichita Business Journal.* September 6, 1991:11.
14. Harlap S, Kost K, Forrest JD. *Preventing Pregnancy, Protecting Health: A New Look at Birth Control Choices in the United States.* New York, NY: The Alan Guttmacher Institute; 1991.
15. *Female Sterilization: A Guide to Provision of Services.* Geneva, Switzerland: World Health Organization; 1992.
16. *Report of a WHO Scientific Group: Mechanism of Action, Safety, and Efficacy of Intrauterine Devices.* Geneva, Switzerland: World Health Organization; 1987. Technical Report Series 753.
17. Coker AL, Harlap S, Fortney JA. Oral contraceptives and reproductive cancers: weighing the risks and benefits. *Fam Plann Perspect.* 1993;25:17–21,36.
18. Petitti DB, Porterfield D. Worldwide variations in the lifetime probability of reproductive cancer in women: implications of best-case, worst-case, and likely-case assumptions about the effect of oral contraceptive use. *Contraception.* 1992;45:93–104.
19. Henshaw SK, Van Vort J. Abortion services in the United States, 1991 and 1992. *Fam Plann Perspect.* 1994;26:100–106, 112.
20. Henshaw SK. The accessibility of abortion services in the United States. *Fam Plann Perspect.* 1991;23:246–252,263.
21. Henshaw SK, Van Vort J, eds. *Abortion Factbook.* New York, NY: The Alan Guttmacher Institute; 1992.
22. Hillman AL, Eisenberg JM, Pauly MV, et al. Avoiding bias in the conduct of cost-effectiveness research sponsored by pharmaceutical companies. *N Engl J Med.* 1991;324:1362–1365.
23. Kestelman P, Trussell J. Efficacy of the simultaneous use of condoms and spermicides. *Fam Plann Perspect.* 1991;23:226–227,232.
24. Trussell J, Stewart F, Guest F, Hatcher R. Emergency contraceptive pills: a simple proposal to reduce unplanned pregnancies. *Fam Plann Perspect.* 1992;24:269–273.
25. Trussell J, Stewart F. The effectiveness of postcoital hormonal contraception. *Fam Plann Perspect.* 1992;24:262–264.
26. Forrest JD, Singh S. The sexual and reproductive behavior of American women, 1982–1988. *Fam Plann Perspect.* 1990;22: 206–214.
27. Hellinger FJ. The lifetime cost of treating a person with HIV. *JAMA.* 1993;270:474–478.
28. *U.S. Population Estimates, by Age, Sex, Race, and Hispanic Origin: 1990 to 1993.* Suitland, Md: US Bureau of the Census; March 1994. PPL-8.
29. *Division of STD/HIV Prevention 1992 Annual Report.* Atlanta, Ga: Centers for Disease Control and Prevention; 1993.
30. *Uneven and Unequal: Insurance Coverage and Reproductive Health Services.* New York, NY: The Alan Guttmacher Institute; 1994.
31. Daley D, Gold RB. Public funding for contraceptive, sterilization and abortion services, fiscal year 1992. *Fam Plann Perspect.* 1993;25:244–251.